



## Pressure Effect on Phase Behavior of Surfactant System

Sandersen, Sara Bülow; von Solms, Nicolas; Stenby, Erling Halfdan

*Publication date:*  
2011

*Document Version*  
Publisher's PDF, also known as Version of record

[Link back to DTU Orbit](#)

*Citation (APA):*  
Sandersen, S. B., von Solms, N., & Stenby, E. H. (2011). *Pressure Effect on Phase Behavior of Surfactant System*. Poster session presented at 25th European Symposium on Applied Thermodynamics, Saint Petersburg, Russian Federation.

---

### General rights

Copyright and moral rights for the publications made accessible in the public portal are retained by the authors and/or other copyright owners and it is a condition of accessing publications that users recognise and abide by the legal requirements associated with these rights.

- Users may download and print one copy of any publication from the public portal for the purpose of private study or research.
- You may not further distribute the material or use it for any profit-making activity or commercial gain
- You may freely distribute the URL identifying the publication in the public portal

If you believe that this document breaches copyright please contact us providing details, and we will remove access to the work immediately and investigate your claim.



# Pressure Effect on Phase Behavior of Surfactant System

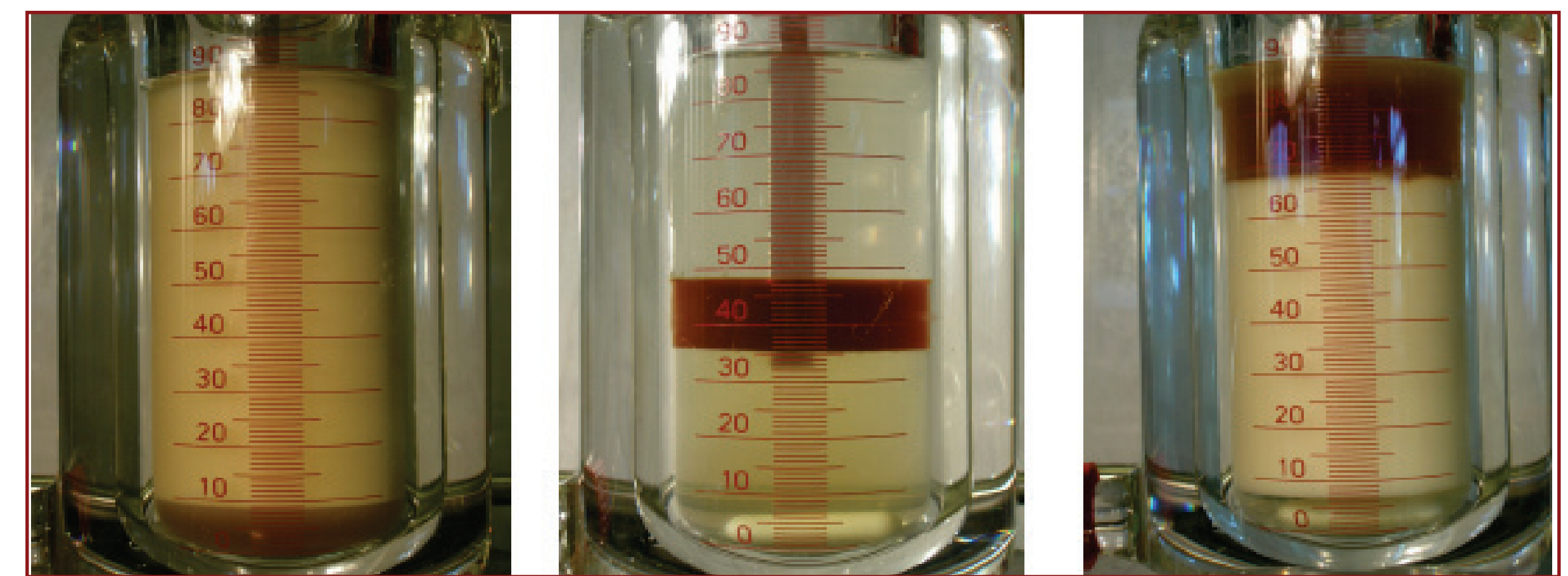
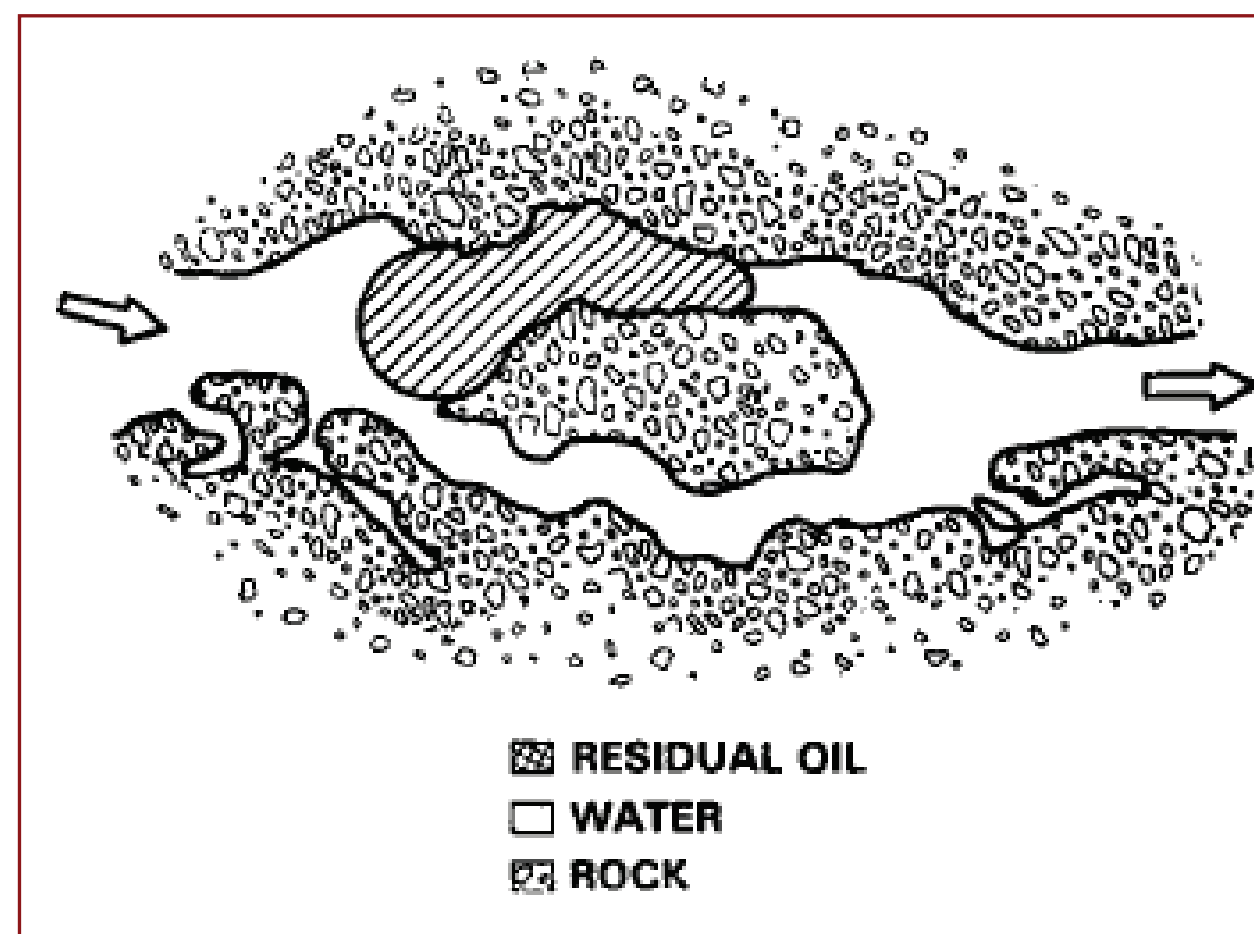
Sara Bülow Sandersen, Erling H. Stenby & Nicolas von Solms

Center for Energy Resources Engineering (CERE), DTU Chemical & Biochemical Engineering, Technical University of Denmark

Contact: sbs@kt.dtu.dk

## Introduction

As more than 50 % of the crude oil is expected to remain trapped in many mature oil reservoirs, tertiary oil recovery techniques must be introduced to keep an efficient oil recovery. This is the so-called Enhanced Oil Recovery (EOR). Surfactant flooding is considered as a potential EOR technique, which basically is the injection of appropriate chemicals (surfactants) into the reservoir to lower the interfacial tension (IFT) to ultra low [1].



3.4 % NaCl

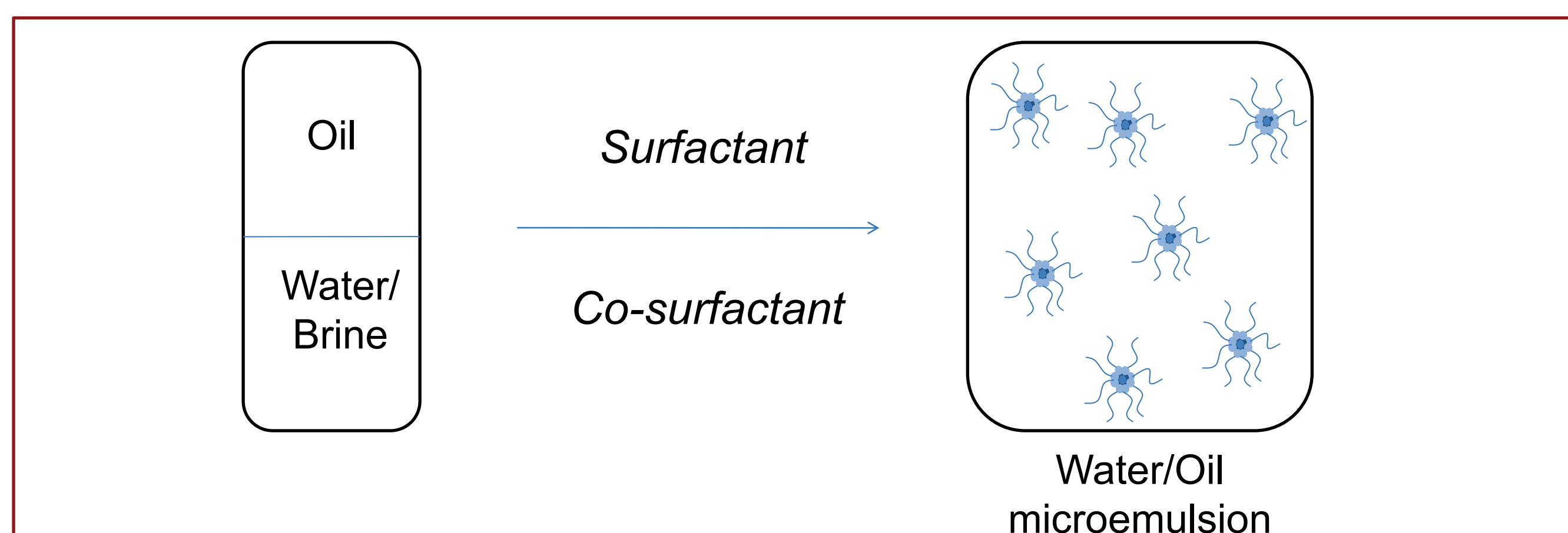
6.5 % NaCl

8.3 % NaCl

Surfactants help mobilizing the trapped crude oil leading to an increase in oil recovery.

The aim in this project is to study surfactant systems phase behavior at elevated pressures as there are no consensus whether pressure effects the formation of the desired three phase area. Several complex issues follows along, such as sensitivity to salinity, adsorption into the reservoir rock, etc.

## Phase Behavior



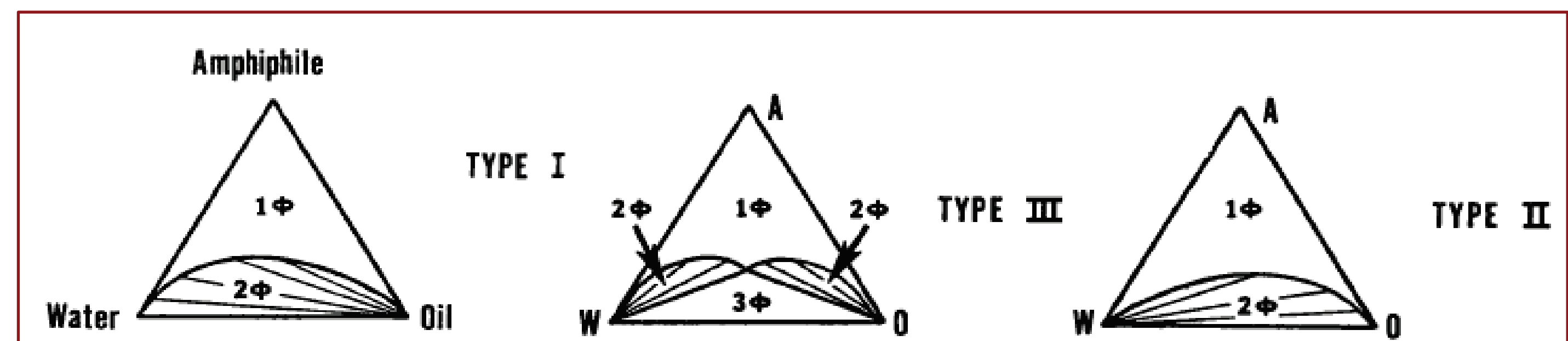
○ **Emulsions:** Formed in mixtures of liquids as droplets either as macroscopic or microscopic size. In surfactant flooding either water/oil or oil/water microemulsions are required, as the microemulsion reduces the IFT between oil and water.

### ○ Facts:

- An increase in temperature entails an increase in optimal salinity.
- Effect of pressure is debatable.

### ○ Type of surfactant systems considered:

- Typically the so-called Winsor type system are used.

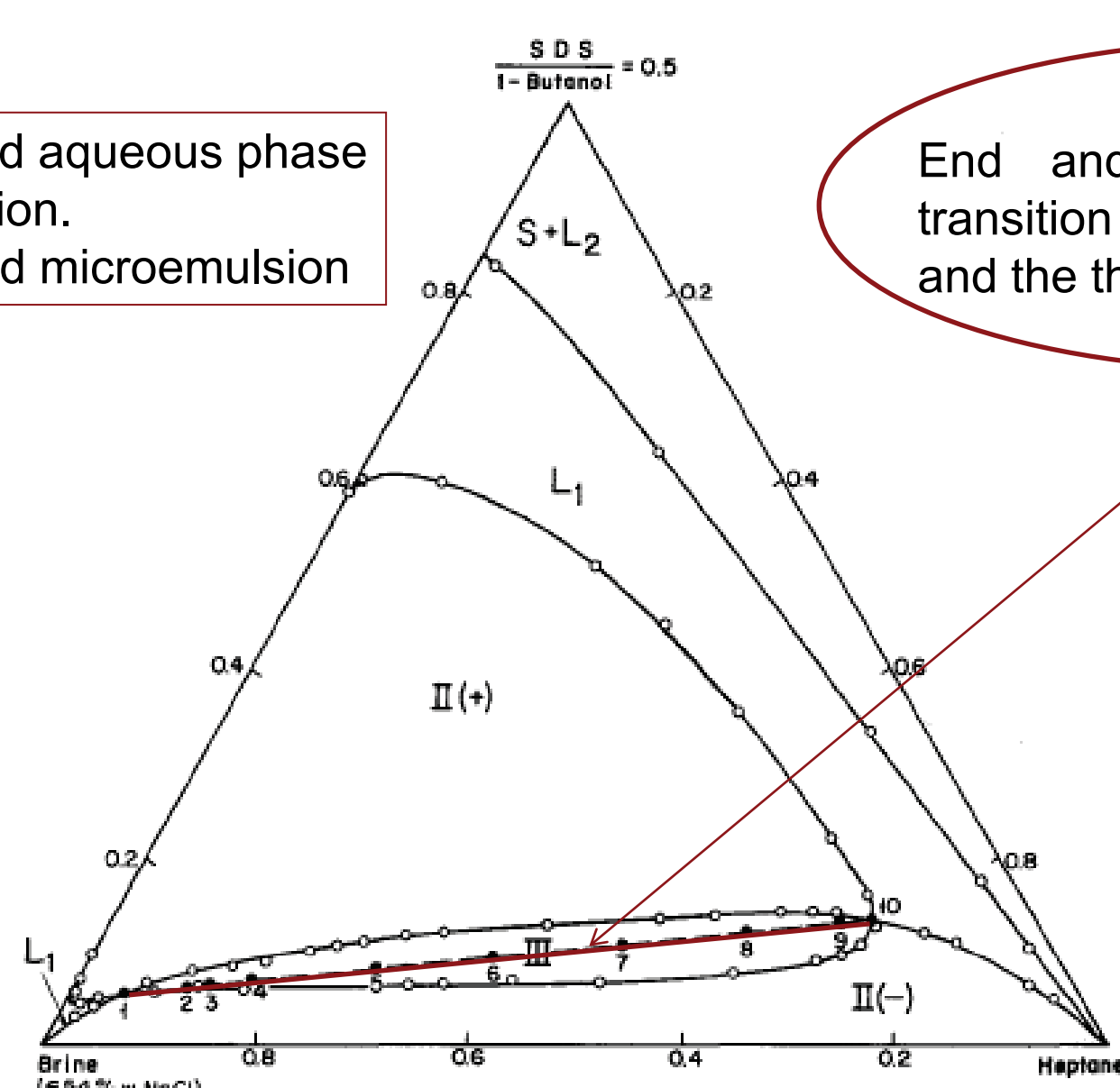


## Experimental Work

### ○ Surfactant system tested:

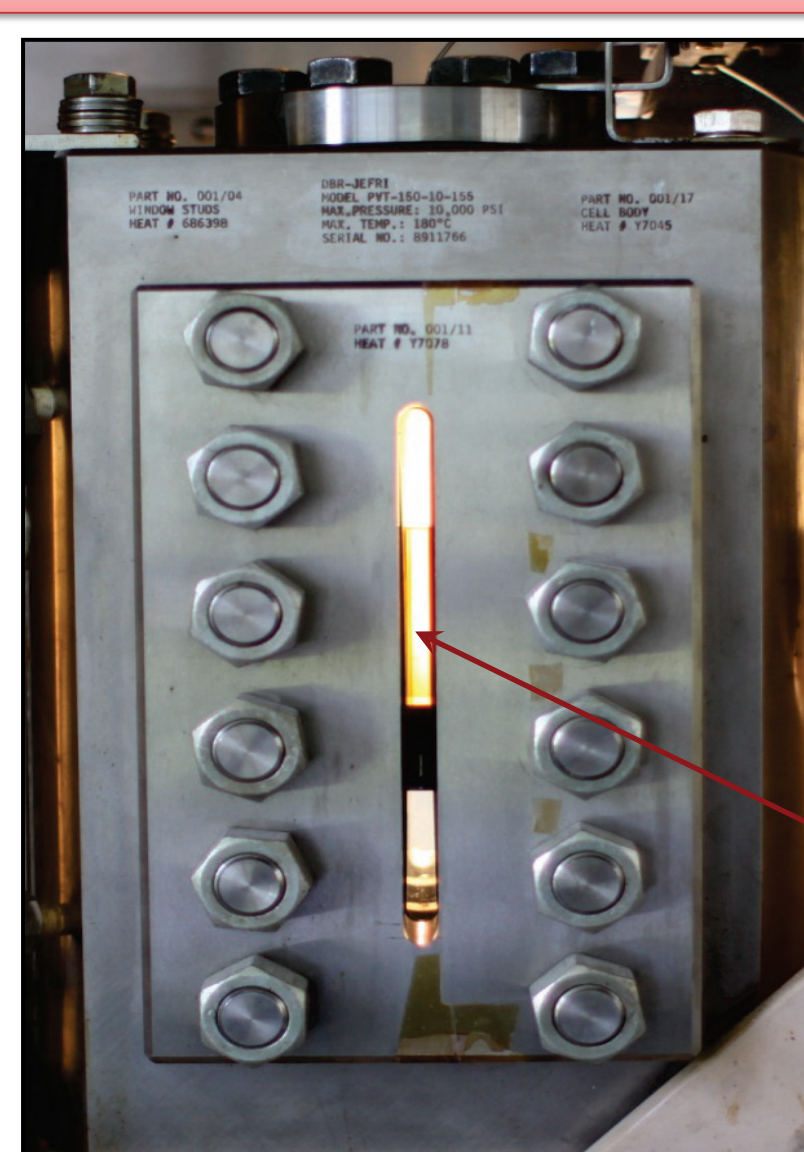
Sodium Dodecyl Sulphate/1-Butanol/Heptane/Water in Sodium Chloride [2].

- II(+) is microemulsion and aqueous phase
- III is the three phase-region.
- II(-) is the oleic phase and microemulsion



End and start point is at the transition points between the single- and the three-phase regions.

DBR JEFRI PVT cell

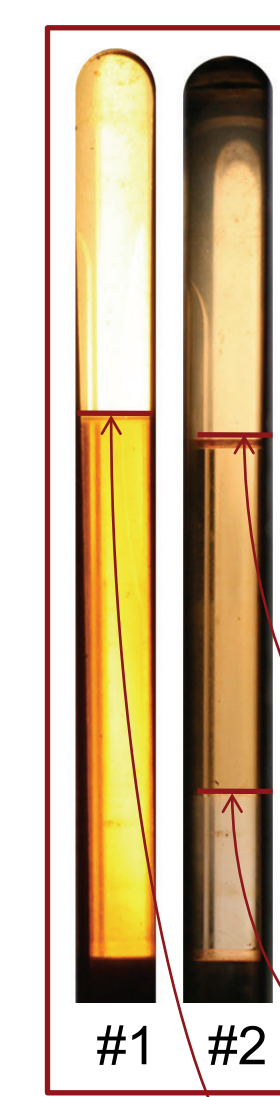


### ○ High pressure equipment:

- DBR JEFRI PVT cell
- Allowing phase volume measurements through a window.
- At a wide range of pressures and temperatures.

Window for measurements

## Results

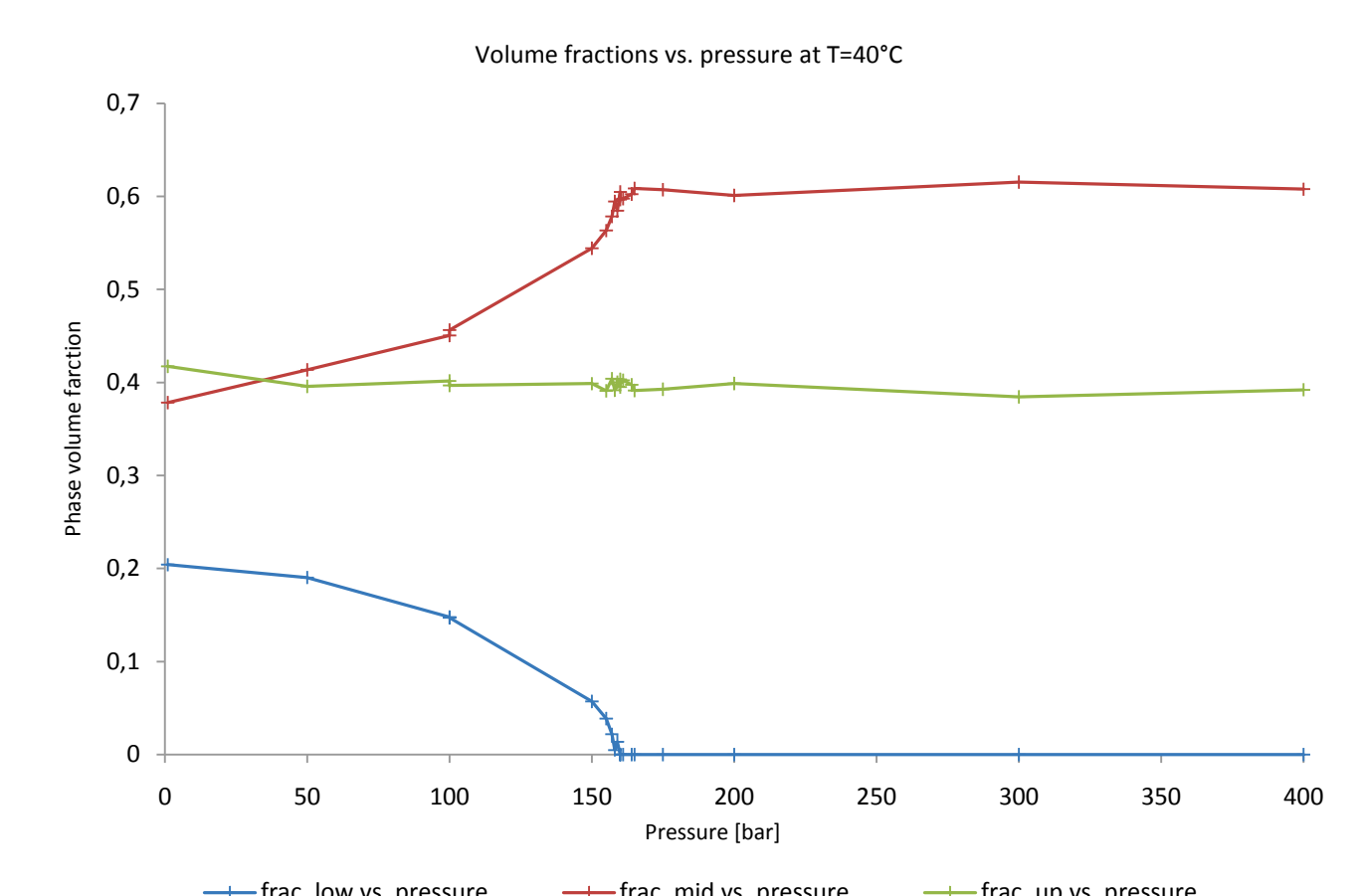
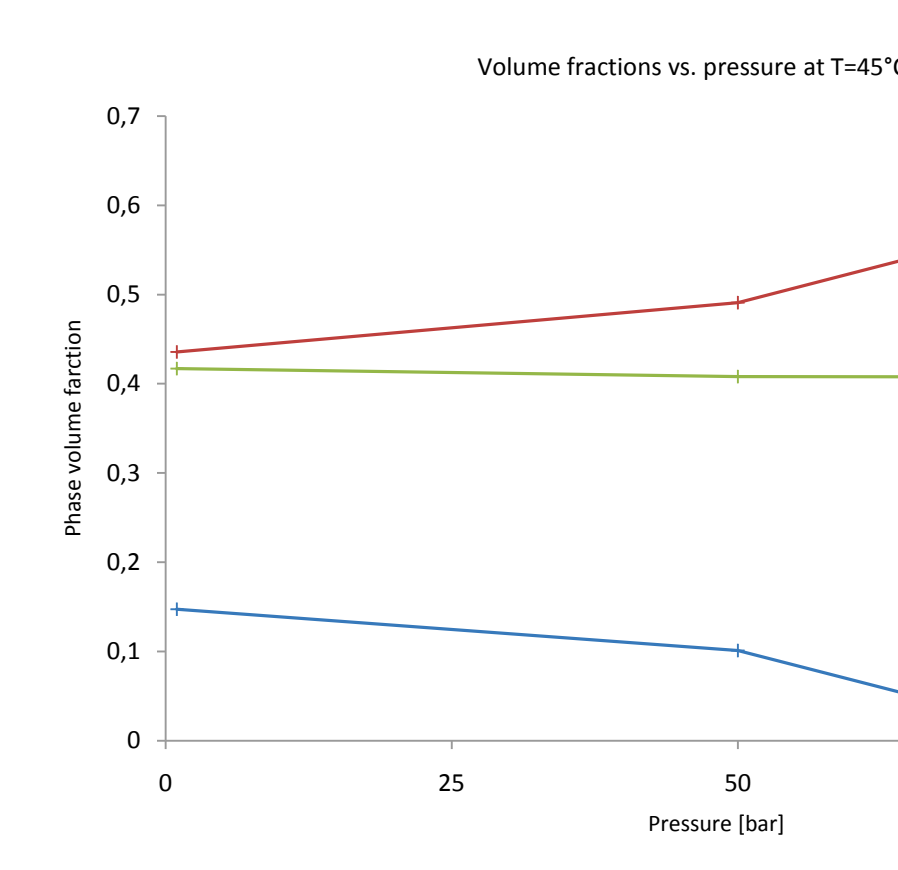


#1: 2 phases at P=78 bar and T=45 °C

#2: 3 phases at P=50 bar and T=40 °C

All observations are reversible and reproduced

Phase boundaries



Changes from 3 to 2 phases dependent on the effect from increase in pressure.

The effect from pressure is enhanced with increases in temperature

## Future Work

Further experimental study of the conditions for change in number of phases, thus presence of an microemulsion phase.

## References

- [1] B.M. O'Brian, Journal of Chemists' Society, (1982), 59, 839a-852s.
- [2] J. Van Nieuwkoop and G. Snoei, Journal of Colloid and Interface Science, (1984), 103, 400-41